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THE EFFECT OF SCIENTIFIC LITERACY ON PUBLIC OPINION OF MILITARY SPENDING LEVELS

by

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THE EFFECT OF SCIENTIFIC LITERACY ON PUBLIC OPINION OF MILITARY SPENDING LEVELS

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In this thesis, I study the association between scientific literacy and individual opinions on military spending of voting-age Americans using data from the 2016 General Social Survey. Based on responses to general science knowledge questions, I created a scientific knowledge test. Individuals were coded as scientifically literate if they answered 10 questions correctly out of the 12 on this test. Using multinomial logistic regression models, I found those exhibiting scientific literacy were 1.88 times more likely to express the opinion that military spending is too high, as compared to individuals classified as not scientifically literate. My results were robust to changes in the passing threshold for the test. Given the growing role of science and technology in the military, further study of this issue may have considerable implications for the education, scientific, and government communities. The findings could be applied to arguments related to the establishment of voter qualifications, changes in funding to science education, or how government agencies convey their spending habits to the public.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAAS	American Association for the Advancement of Science
DoD	Department of Defense
GSS	General Social Survey
NES	National Election Study
NORC	National Opinion Research Center
OLS	ordinary least squares
WEIS	World Event Interaction Survey

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I. INTRODUCTION

> The individual who does not comprehend basic terms like atom, molecule, gravity, or radiation will find it nearly impossible to follow the public discussion of scientific results or public policy issues pertaining to science and technology. In short, a minimal scientific vocabulary is necessary to be scientifically literate.
>
> —Jon D. Miller, *Scientific Literacy*

A. OVERVIEW

My thesis studies the correlation between scientific knowledge or scientific literacy in the voting public and views on military spending. Science and technology permeate all areas of society. From the energy that powers everyday tools, through advancements in health and medicine, or climate and the environment, advanced scientific concepts and technology touch numerous aspects of every citizen's life. As such, the laws and policies related to technological advancements must also progress. In a democratic society, such as the United States, voters have the power to change laws and policies on these hard sciences. With the ability to vote on a policy involving scientific concepts, it is implied that the voter in fact understands these concepts. Without appropriate education on these topics, however, voters could make decisions based on a false understanding. The Department of Defense (DoD), similar to many areas of the public and private sector, is growing in dependence upon advanced scientific concepts and technology. Whether it is stealth technology, artificial intelligence, explosive technologies, or nuclear-powered ships, technology is pervasive—and expensive. Partially due to this dynamic, the DoD's budget has grown considerably in order to support these programs and their increasing scientific and technological dependency (Alic, 2007). The DoD ultimately depends on the support of the voting public in order to fund these endeavors. My study looks at whether different levels of scientific knowledge are correlated with individual opinions on military spending.

My hypothesis is that a greater degree of scientific knowledge, or scientific literacy, will result in a higher likelihood of favoring increased defense spending. It may be that having a higher level of scientific understanding means a deeper appreciation for the sciences' complexity, effort, and most importantly, associated costs. This understanding logically would then extend to the DoD's growing dependence on science and technology, leading the scientifically literate voter to form the opinion that more money is required to sustain those defense advancements.

The implications of this connection between scientific literacy and opinions and voting habits could have significant impacts across government, education, and scientific fields. The results could be applied to arguments for or against the establishment of voter qualifications, changes in funding to science education, or how government agencies convey their spending habits to the public.

I study the association between scientific literacy and individual opinions on military spending by voting age Americans using data from the 2016 General Social Survey (GSS) (General Social Survey, 2016). Based on responses to general science knowledge questions, I created a scientific knowledge test. Individuals were coded as scientifically literate if they answered 10 questions correctly out of the 12 on this test. Using multinomial logistic regression models, I found those exhibiting scientific literacy were 1.88 times more likely to express the opinion that military spending is too high, as compared to individuals classified as not scientifically literate.

I estimated six models, incrementally adding independent variables. The multinomial logistic regression models showed the same directional viewpoint with a similar magnitude, regardless of the set of individual variables included. Relative to respondents who failed the scientific knowledge exam, those who passed were substantially more likely to hold the opinion that we spend too much on defense, even when accounting for veteran status, political party affiliation, and a range of demographic factors.

Specific controls of interest provided both expected and unexpected results. Veterans and Republicans were each much more likely to believe we spend too little on the military. The oldest age group (those 66 and older) were also far more likely to feel that too little is spent on defense. Compared to those with less than a high school diploma, respondents with a bachelor's or graduate degree were much more likely to think the nation spends too much on the military. Female respondents provided the most surprising finding.

Compared to men, this group was less likely to think we spend too much on defense, showing nearly the same magnitude and direction as Republicans.

B. BACKGROUND

The concept of scientific literacy dates back to the 1950s with the advent of nuclear power, and the growing concern for environmental protection (Miller, 1983). With these public concerns, voters were faced with forming opinions and making decisions that required some level of scientific understanding. As stated by researcher Jon Miller, "in a democratic society the level of scientific literacy in the population has important implications for science policy decisions" (Miller, 1983, p. 29).

In the 1960s, voters were often asked to vote on laws and regulations involving scientific concepts, such as nuclear power (Miller, 1983). As more science-based issues appeared on state referenda, there was "apprehension in the scientific community about the public's ability to understand the issues and to make an informed judgement" (Miller, 1983, p. 31) Miller concluded that "the level of scientific literacy in the United States is deplorably low" and corrective actions "will improve the quality of both our science and technology and our political life" (Miller, 1983, p. 29).

DeBoer (2000) commented in his work that "science education can help develop informed citizens who are prepared to deal intelligently with science-related social issues, to vote responsibly, and to influence, where appropriate, policies related to the impact of science on society" (p. 592). This notion of responsible voting readily applies to the realm of national defense, as DeBoer (2000) continues that, "the relationship between science and society involved the growing perception that scientific and technological developments were an important resource for national security" (p. 585).

Among the studies directed in the field of scientific literacy, the National Science Board conducted a study between 1979 and 1981 aiming to identify public attitudes toward science and technology (Miller, 1983). The results of the survey indicated that 20 percent of American adults followed scientific matters and had a greater appreciation for sciences. This was a shockingly low number, corroborating the notion that scientific literacy among the masses was low (Miller, 1983). Without correction, this deficiency would have serious implications on greater society in the future.

In an attempt to remedy this level of scientific literacy, the American Association for the Advancement of Science (AAAS) established criteria for core education standards in U.S. schools. The list of criteria for what core science education should achieve involves the question, “Is the proposed content likely to help citizens participate intelligently in making social and political decisions involving science and technology?” (American Association for the Advancement of Science, n.d.). Unfortunately, even with the advent of core scientific education, scientific literacy still has not improved. In 2016, the University of Michigan conducted a survey testing civic scientific literacy, to determine if respondents had the knowledge required of a citizen to understand basic scientific concepts, “such as the nature of matter, the structure of a molecule or DNA, and the application of probability to simple problems” (Miller, 2016, p. 2). The results of the study found that only 28 percent of American adults met this qualification of civic scientific literacy. This outcome was consistent with results from a similar Michigan study in 2008, indicating that this status has not improved over the past decade, despite efforts of academia (Miller, 2016). Miller concludes that “given the growing number of public policy issues that involve science or technology, the failure of the rate of civic scientific literacy to grow in the past decade is troubling” (Miller, 2016, p. 4).

Miller’s definition of scientific literacy, as used in the 2016 University of Michigan survey is one of the more elementary standards (Miller, 2016). While it asked basic scientific knowledge questions, some researchers such as A. B. Arons (1983), qualify scientific literacy as encompassing far more. Beyond just scientific knowledge, he states that scientific literacy also includes concepts such as experimental design, various research methods, scientific hypothesis testing, scientific philosophy, and theory (Arons, 1983). As he states in his explanation, students should not limit themselves to being able to answer whether the earth revolves around the sun, but also to ask why we believe that the earth revolves around the sun (Arons, 1983). Based on the outcomes of the elementary definition of scientific literacy, a more sophisticated definition such as that of Arons’, would likely yield an even poorer result.

II. LITERATURE REVIEW

This chapter reviews the relevant literature pertaining to this study. The first section covers previous research using GSS data. Then, section two summarizes studies that measure scientific literacy in the United States. Section three discusses studies on national defense spending preferences. The chapter concludes with a brief summary of the literature.

A. GENERAL SOCIAL SURVEY STUDIES

The GSS is a survey for researchers seeking data on contemporary American society. Since its formation in 1972, GSS sociological and attitudinal trend data enables scholars to investigate a wide variety of topics of special interest such as attitudes on race relations, the existence and nature of God, and government spending. Previous research using GSS data has ranged from simple statistical applications such as comparisons of sample averages to more complex endeavors involving, for example, probit and logit regression models.

In one study for example, Raden (1989) uses a national probability sample of 1,323 Caucasians from the 1982 GSS to study the correlates of prejudice with a series of authoritarianism and conservatism-related variables. Although statistically simplistic in nature, the author's analysis met his intended purpose "to provide a considerably more comprehensive GSS-based picture of the syndromic qualities of racial prejudice than is now available" (Raden, 1989, p. 54). His findings suggest that the relationship between prejudice and political conservatism is generally weaker than might be expected based on prior research. Understanding the limitations of his study, the author appropriately notes there are problems moving from descriptive statistics to causal inferences (Raden, 1989). The author's study does not seek to establish a causal relationship because his methodology exclusively uses the creation of correlation matrices, without any deeper analysis.

In the first study to substantially investigate perceptions pertaining to long-term trends in job security, Schmidt (1999) uses a series of cross-sectional GSS surveys from 1977 to 1996. She uses two different dependent variables measuring job security beliefs.

Of interest to my study, both dependent variables are Likert scale responses. Schmidt (1999) deals with the multiple responses by creating a binary dependent variable whereby some answers qualify for a value equal to one. For example, when asked "Thinking about the next 12 months, how likely do you think it is that you will lose your job or be laid off—very likely, fairly likely, not too likely, or not at all likely?," workers who believed there was some degree of likelihood in job loss were coded as one, while both not likely responses received a value of zero (Schmidt, 1999, p. S133). To estimate the effects of independent variables on binary dependent variables, the author uses probit models to analyze trends in job security beliefs, while controlling for variability in the structure of the labor force over time (Schmidt, 1999). The author finds that economic recovery years in the mid-1990s left workers feeling more concerned about holding onto their jobs and about costly job loss relative to previous economic recoveries in the late 1970s and 1980s (Schmidt, 1999).

Of additional relevance to my research is Schmidt's (1999) recognition that many surveys ask similar questions using different wording that may affect a respondent's answers. Within her study, Schmidt found that regardless of question wording or ordering in the other surveys, responses were largely unaffected. Thus, Schmidt (1999) concludes that because these answers were similar, GSS surveys were a reliable indicator of public attitudes.

Brace, Sims-Butler, Arceneaux, and Johnson (2002) use the GSS disaggregated to the state level to test specific measures of state-level opinions on a range of issues. To understand the conditions where a national sample can create representative state samples, the authors conduct a simulation. The authors focus on two measures of interest. The first is *coverage*—the degree to which primary sampling units represent a state's population. They find that as coverage of the total population decreases, bias increases. The second measure is *homology*—the degree to which distribution attributes within a primary sampling unit is similar in proportion to that of the state. The authors also find that when homology decreases, bias increases as well (Brace et al., 2002). Relevant to my research, they use two variables related to government spending, with three possible responses. They assessed attitudes regarding spending on welfare and the environment using the question of whether the country spends too much, too little, or about the right amount. The authors code the “too much” response as zero, “about right” as one half, and “too little” as one. This choice of coding implies that higher scores indicate that respondents support higher government spending on welfare and the environment. Additionally, regression models in the study suggest “specific opinion measures compare favorably with the explanatory power of general political ideology” (Brace et al., 2002, p. 183).

Research by Fong (2001) is of interest because a portion of the author’s study utilizes the same dependent variable from the GSS as this study: opinion on spending levels for the military, armaments, and defense. The author uses ordered probit models to predict support for several federal programs, including national defense (Fong, 2001). These models include independent variables central to the author’s thesis, but of note for my study is Fong’s use of five demographic variables in the GSS: income, education, race, gender, and age (Fong, 2001). There are three possible responses for opinions on military spending: that we spend (1) too little, (2) about the right amount, or (3) too much. Unlike Brace et al. (2002), a response of “don’t know” is coded as missing (Fong, 2001). However, similar to Brace et al. (2002), Fong (2001) inverted response ordering to reflect an increase in military spending support. The author investigates whether opinions on redistribution stem from an individual’s beliefs about distributive justice or from one’s own self-interest. Fong (2001) concludes that beliefs about self-determination “are strong predictors of support for redistribution in the full, high-income, and low-income samples” (p. 240).

Cushing-Daniels and Yeung (2009) use pooled, cross-sectional data from the 1988 to 2006 GSS to examine the effects of sexual orientation on earnings. When discussing previous research conducted on this topic that also utilizes GSS data, they note familiar results in their ordinary least squares (OLS) regressions. However, unlike earlier results, when they correct for differential selection into full-time work, the wage penalty/premium for gay/lesbian workers is statistically different (Cushing-Daniels & Yeung, 2009). This study highlights the need to address the sample selection bias, which in this case is solved using the Heckman selection method.

Most GSS studies document interesting associations among variables of interest but have little intention of addressing causal relationships. Simple correlation matrices present unique perspectives, but even analysis with multivariate regressions do not provide evidence of causality. Omitted variables bias is an issue for most of these studies, potentially biasing the effect of observed covariates upward or downward. In the next section, I discuss studies pertaining to scientific knowledge in the United States.

B. SCIENTIFIC LITERACY

Most of the academic literature on scientific knowledge or scientific literacy is qualitative in nature. Since I have noted several examples in the Background section, here I focus on a few research papers with a quantitative component.

Sherkat (2001) analyzes religion and scientific literacy in the United States, specifically examining how fundamentalist views of the Bible affect scientific literacy. He finds that those with fundamentalist beliefs, such as sectarian Protestants and Catholics, have a significantly lower level of scientific literacy relative to secular Americans. Sherkat (2001) also discovers that the negative influence on scientific knowledge due to religious factors is more impactful than gender, race, or income. On average, respondents who held a literal interpretation of the Bible answered far fewer scientific knowledge questions correctly than those who believed the Bible is a book of fictitious stories.

Using a similar methodology as this study, Sherkat uses the 2006 GSS that incorporates 13 areas related to scientific facts and reasoning. For his specific use, a scientific knowledge question regarding evolution was removed, as a respondent's answer may vary depending on his or her faith (Sherkat, 2001). Of relevance to my research design is the necessary restriction of the sample to include only respondents who take the science exam and answer all scientific knowledge questions. This sample restriction for Sherkat resulted in a random sample of 1,863 respondents out of the 4,510 respondents in the 2006 GSS. The sample would have to be pared down further due to missing values on the covariates. The author's dependent variable of interest is predicted science scores, and he used OLS regressions to estimate them.

Miller (1998) provides the most helpful research for my study, as he outlines the prudent way to measure civic scientific literacy. This term is really what is meant when other authors discuss scientific knowledge or scientific literacy. Miller (1998) defines civic scientific literacy as “a level of understanding of scientific terms and constructs sufficient to read a daily newspaper or magazine and to understand the essence of competing arguments on a given dispute or controversy” (p. 204). Although Miller compares civic scientific literacy results across nations, his analysis is beneficial to the way I utilize the scientific knowledge exam from GSS data. For example, he notes that closed-ended questions have become popular because they are simpler to administer even though open-ended questions enable researchers to obtain a more accurate measure of understanding. Both the 1992 Eurobarometer study and the 1995 United States study referenced by Miller (1998) include a majority of closed-ended questions similar to those found in the GSS, some of which are identical.

For research purposes, there must be a minimum score on a multi-question test that would determine whether an individual possesses civic scientific literacy. Similar to his previous studies, Miller (1998) uses the 67-point level as his threshold, which reflects the ability of a test-taker to get two-thirds of the possible points on the exam. For the 1995 U.S. data, 27.2 percent of Americans scored at or above this level, demonstrating that around three in four adults were “unable to read and understand news or other information that utilized basic scientific constructs such as DNA, molecule, or radiation” (Miller, 1998, p. 213). The 27.2 percent qualifying as being scientifically literate from the 1995 studyis similar to the 28 percent figure found in research conducted in both 2008 and 2016 (Miller, 2016).

To address an individual’s knowledge of scientific study, a survey question may ask what it means to investigate something scientifically (Miller, 2004). An appropriate response to this open-ended question would mention the need to use an experimental method (Miller 2004). Miller explains that to evaluate the understanding of experiments, a question using a drug trial scenario is asked, looking for answers that explain the logic of control and treatment groups. Evaluating a respondent’s grasp of probability is often determined by a question that involves an example of an inherited illness. Other measures of assessment include a recognition that astrology is not scientific and knowledge of specific scientific concepts that represent physical and biological science (Miller, 2004). Miller also notes that questions about widely used items such as antibiotics and lasers are applied to evaluate an individual's knowledge of products developed through scientific research. In subsequent chapters, most of these questions will be identified in the 2016 GSS used in my research. I use similar inquires to create a comprehensive scientific knowledge exam. With relevance to a component of my thesis and its significance, Miller (2004) states that the current level of scientific literacy among U.S. adults "is still problematic for a democratic society that values citizen understanding of major national policies and participation in the resolution of important policy disputes" (p. 273). Therefore, an individual's level of scientific knowledge may affect his or her views on military spending, a topic I turn to next.

C. OPINIONS ON MILITARY SPENDING

The dynamics and significance of the Cold War made it a popular period for the assessment of changing opinions on defense spending. The arms race, which was driven by increases in military spending by both the United States and the Soviet Union, provided various unique covariates for investigation. Hartley and Russet (1992) cover that time frame using regression models to determine if changes in military spending (dependent variable) are influenced by changes in public support for military spending (key independent variable). In their analysis, they use average pooled public opinion measurements from six different survey organizations including the one responsible for the GSS (Hartley & Russet, 1992). They determine that holding other factors constant, when public opinion rises for supporting increases in defense spending, the level of military spending will increase as well (Hartley & Russet, 1992).

Eichenberg and Stoll (2012) extend their period of review to include the post-cold war years, implementing regression models for data from 1967 to 2007. They use Gallup polls rather than the GSS for information on military spending opinions, because, among other reasons, the survey series began earlier than the GSS. The authors aim to provide more information on gender politics using time series research and conclude that, on average, men are more supportive of military spending than women. Eichenberg and Stoll also found that the variation of support for military spending among males and females was similar over time, mostly influenced by the previous year's change in defense spending, war casualties, and differences between military and civilian spending. This finding is supportive of a concept called "parallel publics" developed by Page and Shapiro (1992) in which subgroup policy preferences move in tandem over time, despite having different average levels of support.

Witko (2003) uses quarterly time-series data from 1969 to 1989 to explore "how the public responded to political events when forming defense-spending preferences during the cold war" (p. 380). The World Event Interaction Survey (WEIS) event data set was used for the author's key independent variable, since it contains actual events and statements made by political leaders from both sides of the conflict. Witko generates his dependent variable from the defense-spending opinion index, which was created through the compilation of three survey organizations: American National Election Studies, Gallup, and National Opinion Research Center (in charge of conducting the GSS). Questions from different survey houses are worded differently; however, all three ask whether the respondent favors more defense spending, less defense spending, or the same amount. Important control variables include military spending for a given year, changes in public mood, and a Vietnam War dummy variable to account for an additional threat that could influence defense spending opinions.

Witko constructs Soviet and U.S. belligerence variables by using WEIS data that include physical events such as troop movements and verbal or written statements by leaders that were considered either threatening or conciliatory in nature (Witko, 2003). He finds that U.S. belligerence influenced Americans' opinions toward the Soviets; however, Soviet belligerence did not have a significant effect on Americans' views (Witko, 2003). Other key findings show that when the United States behaved in a more aggressive manner toward the Soviets, the American public expressed greater support for military spending. It is possible that this finding is due to reverse causality, as defense spending opinions may have influenced U.S. belligerence. Actual defense spending exhibits a statistically significant negative effect on defense spending opinions, showing that during times of elevated military spending, the public becomes less favorable to more increases in military spending (Witko, 2003).

Like Witko (2003), Knopf (1998) also looks at public opinion on military spending during the Cold War using a similar average of a collection of surveys from 1965 to 1991. The author also uses the same approach as Witko to define the dependent variable. Knopf defines the dependent variable as the net percentage difference favoring a military spending increase, derived by taking the difference between the percentage claiming that too little is spent and the percentage claiming that too much is spent. This method is preferred for capturing the movement in public opinion in time series studies (Knopf, 1998). Despite using different data sources, both studies control for a similar set of factors such as military spending, Vietnam, and Soviet behavior. Knopf also controls for the annual federal budget deficit to account for domestic economic constraints affecting opinions on military spending levels.

Knopf uses multiple regression analysis and utilizes a series of time lags to explore the extent to which there is delay between changing conditions and the public response (Knopf, 1998). His first test “finds little evidence for the traditionalist hypothesis that there will be dangerous delays before the public responds to changes in external threat” (Knopf, 1998, p. 557). An interesting finding exists with regard to the magnitude of results. Pertaining to military spending, Knopf concludes that if the Soviet Union outspent the United States by $10 billion (in constant 1970 dollars) the opinion shift would be less than 4 percent. Yet, the author notes that previous research has shown that only opinion shifts of 6 percent or more are considered significant (Knopf, 1998).

All of the above studies focus on sentiments around the Cold War era. Bartels (1994) examines this question by using post-Cold War data. He analyzes the determinants of defense spending preferences in 1992 using data from the American National Election Study (NES) survey from that year. Defense spending preferences are reported on a seven-point scale, whereby all responses fall between the extremes of -1 (greatly decrease defense spending) and +1 (greatly increase defense spending). Key explanatory variables include “general political ideology, attitudes toward Russia, willingness to use force, isolationism, and economic stakes in the Pentagon budget” (Bartels, 1994, p. 481). Of note is that the author still includes a control for a respondent’s feelings toward Russia, as this may still be an influential factor on the dependent variable. His economic stakes variable captures the fact that some individuals are beneficiaries of DoD budgetary spending in their state. All else equal, Bartels (1994) finds that conservatives and isolationists, as well as residents whose states are net beneficiaries from DoD spending, all favored more military spending.

D. SUMMARY

The GSS provides a vast array of information on attitudes of the American public. Therefore, researchers have used this source to conduct studies with a varied range of topics, such as exploring prejudice, perceptions about job security, predictors of support for income redistribution, and the effect of sexual orientation on earnings. Although a preponderance of peer reviewed literature on the issue of scientific knowledge discusses history, theory, and definitions, some researchers such as Miller, have provided quantitative results showing that only 28 percent of Americans qualify as being scientifically literate (Miller, 2016). Studies relating to opinions on defense spending levels have utilized numerous survey organizations and often focused on a long period of time to intentionally cover the Cold War era. However, Bartels (1994) measures key determinants of military spending preferences in a more recent foreign policy climate after the conclusion of the Cold War period.

The literature above is used to obtain guidance for control variables, such as income, education, race, gender, and age. My study builds upon this literature on changes in defense spending preferences over time by investigating more recent opinions in a very different sociopolitical environment.

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III. DATA AND METHODOLOGY

This chapter's primary focus is to describe the data used in my regression models. I also explain the construction of the dependent and key independent variables. The first section discusses the data set and the sample population that was surveyed. Then, I describe the creation of key variables and conclude with a discussion of the discrete-choice methodology.

A. DATA

Data for this study come from the 2016 GSS, which was the latest available information at the time of this thesis (General Social Survey, 2016). The GSS is the longest-running survey project managed by the National Opinion Research Center (NORC) at the University of Chicago. The GSS is a nationally representative random sample of adults (18 years or older) living in households in the United States. Since 1994, the GSS has been administered in even numbered years. Beginning in 2006, this survey began including Spanish speaking Americans in their samples in addition to the previous standard of English speakers. A vast majority of GSS data is collected during face-to-face interviews. In rare cases, telephone interviews may take place if an in-person interview is difficult to set up with a sampled respondent. GSS interviews last approximately 90 minutes, but all questions are not asked of all respondents. For example, some queries may not be applicable to certain respondents and other questions may not be included in all samples. The GSS uses two samples, each subdivided into multiple ballots. The survey includes a standard core of questions that are asked of all respondents, covering topics such as demographic and attitudinal information. In a given year, topics of special interest such as the role of government or religion are also included and may only be asked in one out of two samples.

B. SAMPLE POPULATION

The response rate for the 2016 survey was 61.3 percent of targeted respondents, which was the second lowest in the past 40 years. Only the previous survey from 2014 had a lower response rate (60.2 percent). The 2016 GSS did not oversample certain groups, unlike the 1982 and 1987 GSS, which oversampled black respondents. Each of the two samples for the 2016 GSS had a target sample size of 1,500. In order to confirm that the results of the survey are scientifically valid, a random selection of households across the country was chosen. This selection is aimed to represent a cross-section of the United States. Accordingly, each household has an equal chance of being selected to participate. Then, an adult member of the household is randomly selected to complete the interview. The 2016 GSS provides data from 2,867 respondents. Of this total, a random sample of 1,390 individuals were given a scientific knowledge exam. I used responses to this exam to construct my key independent variable. More specifics on this measure are provided in the section below.

C. KEY VARIABLES

This thesis studies the effect of civic scientific literacy on opinions related to defense spending. In this section, I explain how I constructed the dependent and independent variables used in this inquiry. First, I explain the construction of the dependent variable of interest—military spending preferences. I follow with an explanation of the key independent variable—scientific knowledge. Finally, I explain the control variables divided into the following broad categories: demographics, veteran status, political party affiliation, level of interest in international issues, and level of interest in military policy.

The 2016 GSS collected opinions on military spending levels by asking two questions to different groups of respondents. One question asked respondents if we are spending too much, too little, or about the right amount on the military, armaments, and defense (General Social Survey, 2016). This question was asked of 1,437 participants. In another question, respondents were asked, in regard to national defense, whether we are spending too much money, too little money, or about the right amount. This question was asked of the remaining 1,430 individuals out of the total sample of 2,867. For each question, responses were coded one, two, or three, respectively. Those believing that the country spends "too little" on defense received a value of one. Those believing we spend an amount that is "about right" received a value of two. The remaining individuals who felt the U.S. spends "too much" on the military were given a value of three. Using this information, I constructed a new variable, “military_spending,” that combined responses to both questions. If respondents answered “too little” on both questions, I coded this response with a value of one. If they answered “too much” for both questions, I applied a value of three. Respondents claiming about the right amount is spent received a value of two. I dropped all responses from individuals who claimed they “don’t know” or who provided “no answer.”

To determine whether a respondent exhibits civic scientific literacy, I created a scientific knowledge test. The test includes 12 questions that cover both the vocabulary construct dimension and process knowledge dimension of civic scientific literacy discussed by Miller (1998). All test questions were closed-ended, and 11 of the questions were identical to those used by Sherkat (2011) in his 13-question science examination using 2006 GSS data. Considered to be elementary concepts, the questions were in either true/false format, or limited multiple choice format. To earn a point for a test question, the respondent had to answer the question correctly. Indicating that he or she did not know the answer or not answering the question at all were considered incorrect and received a score of zero. Not knowing the answer was the same thing as getting the answer wrong in this case because I am trying to determine if an individual is scientifically literate. An admission of not knowing signifies the respondent does not understand the concept being asked. The mean score for Sherkat’s exam was 8.4, thus the average percentage score for his 13-question test was around 65 percent (Sherkat, 2001). For my 12-question science test, the mean score is eight, yielding an average performance of 67 percent. The scientific knowledge test questions and respective percent correct are shown in Table 1 of the Results chapter.

Next, I determined how many total questions were answered correctly by respondents in order to identify a cut-off point for passing or failing the exam. As previously noted, Miller (1998) uses a 67-point level as his threshold. This level is obtained in my test when a respondent answered eight or more questions correctly out of the 12 total. However, nearly 61 percent of respondents performed at this level, indicating that over half demonstrated civic scientific literacy. This figure is far too high, particularly given that Miller (2016) found this measure to be around 28 percent not only as recently as 2016, but over the past decade as well. His analysis involved tests that were more difficult, often including open-ended survey questions which respondents performed much worse on than the closed-ended questions (Miller, 1998). The GSS test questions I use are not open-ended, so it is reasonable that respondents performed better on the scientific knowledge exam used for this study. To achieve a similar scientific literacy rate as established in prior studies, I set the pass/fail threshold at 10 or more questions being correctly answered. Only 31 percent of respondents performed at this level, similar to the 28 percent that Miller has identified as scientifically literate over many years. Therefore, respondents who answered 10 or more of the test questions correctly are considered to possess civic scientific literacy. In my models, I include a binary variable where a passing score takes on a value of one, and a failing score receives a zero. Table 2 in the Results chapter lists the percentage of respondents with each test score. I also ran robustness checks using eight questions or nine questions correct as the cut-off for passing the exam.

Since individual demographics can be correlated with both scientific literacy and preferences on military spending, I used the following control variables in my regressions: gender, education, age, race, marital status, and income. To account for potential differences in opinions due to gender, I included an indicator for females. To control for differences in education, I created indicator variables based on the highest degree earned by the respondent. These indicators include those who have less than a high school diploma, high school, junior college, a bachelor's degree, or a graduate degree. Those individuals with less than a high school diploma serve as the reference group in my regressions.

For the 2016 GSS, the age of respondents ranged from 18 to those 89 and older. These values were presented as a continuous variable. Adding age as a variable only allows for the liner effects of age. I preferred to include the full set of age dummy variables with indicators for each age because it would be more flexible and allow for non-linear age effects. However, adding individual age dummy variables for each age would have been too much given the number of observations. So, I grouped individuals into the following age categories: 18–25 (reference group), 26–35, 36–45, 46–55, 56–65, and those aged 66 and older.

The survey divided race into three categories: white, black, and other. I constructed indicators for each group with white as the reference group in the regressions. To control for marital status, all non-married (widowed, divorced, separated, or never married) respondents received a value of zero, while married individuals take on a value of one. A respondent's family income is used to account for differences in income levels. Total family income ranged from under $1,000 to $170,000 or more, and were reported in very narrow bins. I broke the various levels into the following six income bins: below $25,000 (reference group), $25,000–$49,999, $50,000–$74,999, $75,000–$109,999, $110,000–$149,999, and those earning $150,000 and above. For the age and income variables, I wanted to produce results for commonly-identified income and age groups, such as those likely retired or near retirement and low-income families.

Opinions on the level of defense spending may be influenced by whether an individual has served in the military. To account for this factor, I include a binary variable for being a veteran. The GSS asked respondents the number of years they have spent in the Armed Forces. I designated any number of years above zero to receive veteran status. One survey response category was service for less than two years. Thus, their inclusion in the veteran variable may dampen the effect of being a veteran—it is possible that such a short service period means the individual does not share the same feelings or views toward the military as a service member who at least completed one service contract.

Political ideology affects opinions on many policies, foreign and domestic; therefore, it must be controlled for in my regression analysis. The GSS asked survey participants to state their political party affiliation on an eight-item scale. The GSS categories for political affiliation were: strong democrat, not strong democrat, independent near democrat, independent, other party, strong republican, not strong republican, independent near republican. Of these categories, six identified with either the Republican or Democratic party. I converted the information into a binary variable that grouped three of the categories into Republicans, and all non-Republicans (Democrats, Independents, other party affiliations) were given a value of zero.

A citizen who is interested in both international issues and military policy may be predisposed to certain beliefs about the proper level of military spending. Therefore, I controlled for both categories in my regressions. Survey participants were asked if they are very interested, moderately interested, or not at all interested in international issues and military policy. I created two binary variables, one for each topic, with those who are very interested or moderately interested receiving a value of one, and those who are not at all interested receiving a value of zero.

D. METHODS

In keeping with my research question, my dependent variable assessed respondent's opinions on military spending. The survey allowed for three responses, thus the natural choice of estimation method is multinomial logistic regression. To interpret the coefficients, I used relative risk ratios. Additionally, under the multinomial model, I set the "about right" response as the baseline which served as a comparison for the opinions expressing that too little or too much is spent on the military.

A multinomial logistic regression model is a type of discrete choice model. The outcome choices in my model are distinct and mutually exclusive: individuals only can choose one option. Therefore, the ordering of opinions that we spend too much, too little, or about the right amount does not matter. The survey question about military spending preferences does not provide a single choice for participants. If participants were merely asked if they think we should spend more on defense, then the data would come in a binary form and the model would be a discrete binary choice model. However, with three response options for the survey question, these multiple preferences require a multinomial choice model.

Since the choices cannot be ordered, dependent variables of this type are often modeled as multinomial logit estimated by maximum likelihood methods to evaluate the probability of categorical membership. The logic of this model is to interpret the regression coefficients relative to some base, which I establish as the opinion that we spend about the right amount on the military. The log odds of the outcome choices are estimated as a linear combination of the independent variables in my model. The ratio of the probability of choosing the outcome category of "too much" or "too little" over the probability of choosing the baseline of "about right" is described as relative risk. Such relative risk ratios allow for a standard interpretation of the coefficients, namely they provide a relative risk ratio for a unit change in the independent variable.

I estimated six models where independent variables were entered incrementally in groups. Model 1 looks at opinions on military spending as explained by my key independent variable—scientific knowledge. Model 2 includes controls for the most basic demographic factors such as gender, race, and age of the individual. Model 3 adds the remaining demographic categories of income, education, and marital status. Model 4 includes the veteran status of respondents. Model 5 includes an additional control for political party affiliation. Model 6, the most comprehensive model, adds controls for interest in international issues and military policy.

Even though I include a broad set of control variables, this analysis cannot be interpreted as a causal effect of scientific literacy on preferences for military spending. Rather, it estimates an association between scientific literacy and preferences for military spending controlling for a large set of demographic variables that are likely correlated with the two. Despite the large set of controls, individuals who are scientifically literate are likely to be different from those who are not in both observable and unobservable dimensions. Hence, omitted variables bias is an important concern. While we do not want to interpret these coefficients as causal estimates, these associations are nonetheless very interesting because they inform us about the factors influencing individual opinions on defense spending in the United States. In the next chapter, I turn to summary statistics and present the regression results.

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IV. RESULTS

This chapter describes the results from my multinomial logistic regression models introduced in the previous chapter. I begin by discussing my key independent variable and address how well respondents answered the scientific knowledge exam questions. I then provide a summary of my dependent variable, showing the breakdown of opinions on military spending. Next, I present the descriptive statistics for the full GSS sample and the truncated regression sample. I also display my regression results and include interpretations of the relative risk ratios of statistical significance. Finally, I discuss my results regarding a robustness check that incorporates a lower passing threshold for the scientific literacy exam.

A. SCIENTIFIC KNOWLEDGE TEST RESULTS

The results for each of the 12 questions from my constructed scientific knowledge test are presented in Table 1. There was no single question for which all respondents were wrong, nor was there a question that all participants answered correctly.

The two most problematic questions for respondents involved their understanding of lasers and electrons. Only 45 percent of test takers correctly knew that lasers do not work by focusing sound waves. Just 48 percent of respondents correctly understood that electrons are smaller than atoms. With only a slight improvement, just over half of test takers (51 percent) knew that antibiotics do not kill viruses. The best results for respondents involved their understanding that the center of the earth is very hot, with 84 percent answering this question correctly. Showing similar competency, 81 percent of test takers knew that the continents have moved over time and will continue to do so.

Table 1. Scientific Knowledge Test Questions

	Percent Correct
State "False" that "Antibiotics kill viruses as well as bacteria"	51
State "True" that "The center of the Earth is very hot"	84
State "True" that "Electrons are smaller than atoms"	48
State that the Earth revolves around the sun and not the other way around	71
State "True" that "It is the father's gene that decides whether the baby is a boy or a girl"	60
State "False" that "Lasers work by focusing sound waves"	45
State "True" that "The continents on which we live have been moving their locations for millions of years and will continue to move in the future"	81
State "False" that "All radioactivity is man-made"	69
State that astrology is "not at all scientific"	60
Understand the meaning of the probability of one-in-four given an example of an inherited illness regarding each child's risk	73
Understand the meaning of the probability of one-in-four given an example of an inherited illness when first child's status is identified	83
State that a two-group experimental model is the best way to test a drug	79

As noted in the previous chapter, I established a threshold of 10 correct answers to identify a passing score, and thus classifying as scientifically literate. To do so, I assessed the number of total questions answered correctly by each test taker. The percentage of respondents with each test score is shown in Table 2.

Table 2. Number of Test Questions Correct

Number Correct	Number of Respondents	Percent of Respondents
0	6	0.43
1	6	0.43
2	16	1.15
3	35	2.52
4	60	4.32
5	86	6.19
6	150	10.79
7	190	13.67
8	207	14.89
9	198	14.24
10	198	14.24
11	149	10.72
12	89	6.40
Total	1,390	100

Of the 1,390 test takers, six respondents answered zero questions correctly. Six individuals also only answered one question correctly out of the 12-item exam. A quarter of the test takers scored 50 percent or less, answering six or fewer questions correctly. On the other end of the spectrum, there were 89 individuals who scored perfectly on the knowledge test, equating to roughly 6 percent of all test takers. As noted earlier, the mean score on the test was eight with a standard deviation around 2.5, meaning that the average performance was a score of 67 percent.

B. OPINIONS ON MILITARY SPENDING

Figure 1 shows respondents' opinions on military spending. The column clusters address opinions regarding different samples and question wording. Please note from the last section, one set of respondents were asked whether we are spending too much, too little, or about the right amount on the military, armaments and defense (question "natarms"). The other question asked survey participants if we are spending too much, too little, or about the right amount on national defense (question "natarmsy"). One group was asked the first question and the second group was asked the second variant of the question. No individuals were asked both questions. Reassuringly, both questions show a near identical breakdown of spending opinions. The most prevalent viewpoint was that we spend too much on the military, with 38 percent of respondents making this claim regardless of question wording. The second most popular view was that we spend about the right amount, with 35 percent of survey participants providing this answer. Roughly 27 percent of respondents felt that the country spends too little on the military.

The third column cluster shows the combined opinions of all respondents who answered either of the above questions. This pooled response serves as my dependent variable for the regression analysis that follows. Because the responses are a merged total, all opinion categories are represented by roughly the exact percentages as both the above figures.

The final grouping was developed to display the opinions on military spending among just the scientific knowledge test takers. There were 1,390 test takers, making up roughly 48 percent of the 2,867 respondents in the full GSS sample. This sample of respondents shows a slightly more dovish attitude toward defense spending. A belief that we spend too much is 1.6 percentage points higher than for the full sample. Additionally, the viewpoint that we spend too little on the military is 1.7 percentage points lower than the full sample. The overall opinion breakdown for defense spending among the science test takers remains in very close alignment with the overall sample of GSS respondents.

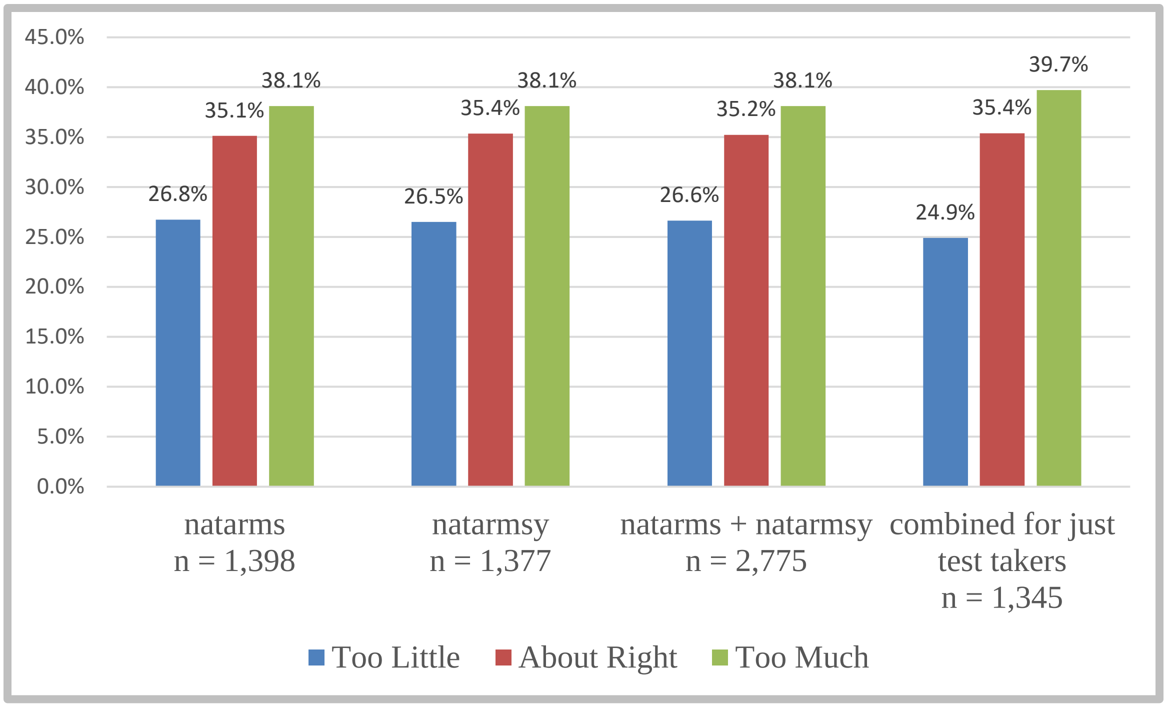

Figure 1. Opinions on Military Spending

C. DESCRIPTIVE STATISTICS

In column one of Table 3, I show summary statistics for the entire survey sample. Column two of the table shows the descriptive statistics for the respondents who took the scientific knowledge test. This table allows us to see if the scientific knowledge test-takers are different from the rest of the GSS sample. They are similar on most dimensions, other than views on international issues and military policy.

Table 3. Descriptive Statistics for Control Variables

Variables	Whole Sample	Science Test Takers
Male	46%	43%
Female	54%	57%
White	75%	75%
Black	16%	15%
Other Race	9%	10%
Age 18–25	9%	10%
Age 26–35	18%	20%
Age 36–45	16%	14%
Age 46–55	18%	17%
Age 56–65	19%	19%
Age 66 and older	19%	20%
Income below $25,000	26%	26%
Income $25,000-$49,999	23%	22%
Income $50,000-$74,999	18%	19%
Income $75,000-$109,999	15%	15%
Income $110,000-$149,999	9%	9%
Income above $150,000	9%	9%
Less than High School	10%	11%
High School	51%	50%
Junior College	8%	8%
Bachelor’s Degree	19%	19%
Graduate Degree	12%	12%
Married	43%	43%
Veteran	11%	11%
Republican	33%	35%
International Issues Interest	87%	73%
Military Policy Interest	92%	84%
Observations	2,517	1,221

The majority of survey participants and scientific knowledge test takers are female, comprising of 54 percent and 57 percent, respectively. Both samples are 75 percent white with a near identical breakdown among blacks and other races. Ages were also similar between the total sample and sub-sample, with my regression reference group (age 18–25) making up 9 percent and 10 percent, respectively. Family income was also nearly identical across all bins, with the same percentage (26 percent) falling into the reference category of less than $25,000. Educational degree attainment was similar as well with around half of both samples earning a high school diploma. Respondents in each group also received a bachelor's degree and graduate degree in the same proportion, 19 percent and 12 percent, respectively. Just under half of each group (43 percent) are married.

For both samples, 11 percent of respondents are veterans. The group of test takers identifying as Republican are just 2 percentage points higher than the overall sample of 33 percent. The largest deviations between samples were for those expressing an interest in international issues and military policy. Notably, 73 percent of test takers take interest in international issues, 14 percentage points lower than the full sample. Additionally, 84 percent of test takers expressed interest in military policy, 8 percentage points lower than the total group of respondents.

D. MULTIVARIATE RESULTS

Table 4 presents the results of the multinomial logistic regressions for the most basic models. Each model contains two columns to cover two of the three outcome responses (that we spend too little or too much on the military) with the omitted reference group covering the opinion that we spend about the right amount. Relative risk ratios greater than one signify that a respondent is more likely to hold the particular opinion in the corresponding column relative to the base that about the right amount is spent on the military. Relative risk ratios less than one signify that a respondent is less likely to hold the particular opinion in the corresponding column relative to the base that about the right amount is spent on the military. Regressing only the dependent variable on my key independent variable yields statistical and economic significance. As noted in Model 1, compared to those who fail, those who pass the scientific knowledge test are 2.09 times more likely to think we spend too much on the military, relative to about the right amount. The results are statistically significant at the 1 percent level.

Table 4. Regression Table with Demographic Controls

VARIABLES	Model 1		Model 2		Model 3	
	(1)	(2)	(3)	(4)	(5)	(6)
Reported as relative risk ratios	Too Little	Too Much	Too Little	Too Much	Too Little	Too Much
Scientific Literacy	1.030	2.086***	0.977	1.904***	1.014	1.796***
	(0.150)	(0.324)	(0.149)	(0.309)	(0.164)	(0.314)
Female			1.018	0.603***	1.036	0.565***
			(0.142)	(0.0925)	(0.146)	(0.0887)
Black			0.586***	0.952	0.647**	0.906
			(0.113)	(0.199)	(0.128)	(0.193)
Other Race			0.492***	0.838	0.526***	0.820
			(0.117)	(0.205)	(0.128)	(0.205)
Age 26–35			1.622*	1.048	1.494	1.051
			(0.477)	(0.277)	(0.452)	(0.291)
Age 36–45			2.342***	0.881	2.169**	0.875
			(0.712)	(0.259)	(0.682)	(0.271)
Age 46–55			2.014**	0.969	1.844**	1.059
			(0.595)	(0.266)	(0.566)	(0.309)
Age 56–65			2.730***	0.586*	2.521***	0.592*
			(0.781)	(0.168)	(0.746)	(0.178)
Age 66 and older			3.281***	0.682	3.382***	0.642
			(0.942)	(0.199)	(0.998)	(0.195)
Inc $25K-$49.9K					1.215	1.276
					(0.247)	(0.282)
Inc $50K-$74.9K					1.688**	1.110
					(0.376)	(0.279)
Inc $75K-$109.9K					1.219	0.582*
					(0.296)	(0.167)
Inc $110K-149.9K					1.231	0.848
					(0.359)	(0.272)
Inc above $150K					1.139	0.875
					(0.355)	(0.295)
High School					1.121	0.993
					(0.259)	(0.275)

VARIABLES	Model 1		Model 2		Model 3	
	(1)	(2)	(3)	(4)	(5)	(6)
Reported as relative risk ratios	Too Little	Too Much	Too Little	Too Much	Too Little	Too Much
Junior College					1.137	1.496
					(0.363)	(0.550)
Bachelor's Degree					0.962	1.729*
					(0.273)	(0.558)
Graduate Degree					0.672	2.133**
					(0.213)	(0.737)
Married					1.221	0.690**
					(0.192)	(0.126)
Constant	1.094	0.544***	0.575**	0.891	0.423**	0.869
	(0.0864)	(0.0523)	(0.157)	(0.224)	(0.148)	(0.309)
Observations	1,221	1,221	1,221	1,221	1,221	1,221
seEform in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

With no controls appearing in Model 1, the effect of scientific literacy is overstated due to omitted variables bias. Model 2 adds basic demographic controls for gender, race and age. Those who are considered scientifically literate are again much more likely to believe that we spend too much on defense. Model 3 builds onto prior controls by adding the remaining demographic factors relating to family income, education, and marital status. Again, the results indicate that respondents who pass the scientific knowledge exam are far more likely to think the government spends too much on the military. The outcome is also statistically significant at the 1 percent level. The magnitude of the association is reduced as I control for more factors, although even Model 3 finds that, compared to respondents who are not scientifically literate, those who are scientifically literate are around 1.8 times more likely to think too much is spent on the military, holding all other variables constant.

A surprising finding comes from the gender indicator. In both Model 2 and Model 3, the relative risk ratio for females is inverted from the scientific literacy variable. Rather than being above one as found with the key independent variable, the female coefficient is less than one. For example, Model 3 finds that women are less likely than men to think we spend too much on defense relative to about the right amount by a factor of 0.57. The directional viewpoint of this finding is the opposite of what Eichenberg and Stoll (2012) conclude.

Table 5 uses the same multi-column format as Table 4, but the multinomial logistic regressions include more controls. When controlling for veteran status, Model 4 shows that the scientific literacy variable increases in magnitude from the prior model. Model 5 also shows an increase in magnitude once controlling for a respondent's political affiliation. The most comprehensive and final model is Model 6, which adds controls for interest in international issues and interest in military policy. The key independent variable for all models in Table 5 is statistically significant at the 1 percent level. In Model 6, I find that, on average, compared to those who fail the scientific literacy test, respondents who pass are 1.88 times more likely to think our country spends too much on the military, all else equal.

The indicator for female maintains approximately the same magnitude and directional viewpoint in all six models. Model 6 results show that compared to men, women are about 0.51 times as likely to think we spend too much on defense relative to about the right amount. Regarding race, the coefficient on black is no longer statistically significant after I control for other factors in the final model. However, compared to white respondents, individuals of other non-black races are 0.61 times as likely to think we spend too little on the military relative to about the right amount. This finding is statistically significant at the 5 percent level and means that individuals of other races want to spend less on defense than whites.

There are numerous age control groups that are statistically significant, but the category of greatest magnitude is for those age 66 and older. Model 6 finds that compared to 18–25-year-olds, this group is 3.28 times more likely to believe that we spend too little on the military. This outcome represents a very hawkish viewpoint from those respondents in the oldest age block. Controlling for family income was important to isolate the true effects of scientific literacy on defense spending opinions, but these regression categories do not provide any statistically significant insight about income effects.

Controls for educational degree attainment are interesting. Regarding Model 6, compared to those with less than a high school diploma, respondents with a bachelor's degree are almost twice as likely to think we spend too much on defense. An even stronger relationship exists for those with a graduate degree. Respondents with this high level of education are 2.09 times more likely to think we spend too much on the military compared to those with less than a high school diploma. Both education categories are statistically significant at the 5 percent level. Marital status loses much of its statistical significance resulting from Model 3 and Model 4 in the last two models. But, assessing the results at the 10 percent significance level, compared to those who are not married, married respondents are 0.72 times as likely to think we spend too much on the military relative to about the right amount. This finding is the same directional opinion as females, although with less magnitude.

The indicator for veteran status yields the expected result. In the most comprehensive model, veterans are 1.7 times more likely to think we spend too little on the military relative to non-veterans. Also, as expected, Republicans are 2.44 times more likely to believe the country spends too little on defense relative to non-Republicans. Similar statistical significance at the 1 percent level also exists for the inverse relationship. For example, Republicans are 0.42 times as likely to think we spend too much on the military compared to about the right amount, relative to non-Republicans. The effects may be even larger if the reference group was just Democrats rather than also including Independents. This result closely resembles the opinion and impact noted by women, which is again surprising, especially when finding a negative correlation between female respondents and Republicans.

The final controls are both statistically significant at the 5 percent level. Respondents who expressed an interest in international issues are 0.7 times as likely to think we spend too little on the military, relative to those with no interest. This group believes in less spending for defense relative to then current levels in 2016. However, survey participants who claimed to be interested in military policy are 1.67 times more likely to believe we spend too little on the military. This group feels there should be more money for defense relative to the levels in 2016.

Table 5. Regression Table with Additional Controls

VARIABLES	Model 4		Model 5		Model 6	
	(1)	(2)	(3)	(4)	(5)	(6)
Reported as relative risk ratios	Too Little	Too Much	Too Little	Too Much	Too Little	Too Much
Scientific Literacy	1.003	1.823***	0.981	1.875***	1.010	1.884***
	(0.163)	(0.319)	(0.162)	(0.334)	(0.168)	(0.340)
Female	1.171	0.537***	1.277	0.514***	1.273	0.510***
	(0.177)	(0.0871)	(0.198)	(0.0848)	(0.199)	(0.0852)
Black	0.633**	0.924	0.833	0.774	0.812	0.780
	(0.126)	(0.198)	(0.171)	(0.169)	(0.168)	(0.170)
Other Race	0.527***	0.827	0.582**	0.788	0.613**	0.780
	(0.128)	(0.207)	(0.144)	(0.199)	(0.153)	(0.198)
Age 26–35	1.484	1.059	1.623	1.020	1.596	1.033
	(0.450)	(0.294)	(0.502)	(0.288)	(0.495)	(0.293)
Age 36–45	2.158**	0.890	2.366***	0.875	2.394***	0.870
	(0.679)	(0.276)	(0.761)	(0.274)	(0.772)	(0.274)
Age 46–55	1.813*	1.076	1.848*	1.099	1.828*	1.138
	(0.558)	(0.315)	(0.580)	(0.327)	(0.575)	(0.340)
Age 56–65	2.461***	0.612	2.582***	0.601*	2.582***	0.616
	(0.731)	(0.185)	(0.783)	(0.184)	(0.787)	(0.190)
Age 66 and older	3.094***	0.696	3.090***	0.712	3.278***	0.715
	(0.922)	(0.214)	(0.939)	(0.223)	(1.006)	(0.226)
Inc $25K-$49.9K	1.189	1.297	1.181	1.309	1.170	1.312
	(0.243)	(0.288)	(0.246)	(0.294)	(0.244)	(0.295)
Inc $50K-$74.9K	1.625**	1.135	1.512*	1.189	1.504*	1.184
	(0.364)	(0.286)	(0.346)	(0.303)	(0.345)	(0.302)
Inc $75K-$109.9K	1.212	0.583*	1.236	0.593*	1.251	0.593*
	(0.295)	(0.168)	(0.307)	(0.171)	(0.311)	(0.171)
Inc $110K-149.9K	1.198	0.858	1.187	0.841	1.177	0.840
	(0.351)	(0.275)	(0.354)	(0.274)	(0.353)	(0.274)
Inc above $150K	1.133	0.875	1.013	0.888	1.019	0.880
	(0.354)	(0.296)	(0.324)	(0.306)	(0.328)	(0.304)
High School	1.101	1.011	0.960	1.078	1.024	1.049
	(0.255)	(0.280)	(0.226)	(0.301)	(0.244)	(0.295)

VARIABLES	Model 4		Model 5		Model 6	
	(1)	(2)	(3)	(4)	(5)	(6)
Reported as relative risk ratios	Too Little	Too Much	Too Little	Too Much	Too Little	Too Much
Junior College	1.055	1.543	0.954	1.578	1.014	1.529
	(0.340)	(0.570)	(0.313)	(0.588)	(0.337)	(0.573)
Bachelor's Degree	0.953	1.753*	0.749	2.035**	0.815	1.947**
	(0.270)	(0.566)	(0.218)	(0.668)	(0.240)	(0.646)
Graduate Degree	0.676	2.133**	0.648	2.187**	0.727	2.089**
	(0.215)	(0.737)	(0.209)	(0.762)	(0.238)	(0.738)
Married	1.211	0.694**	1.159	0.706*	1.162	0.715*
	(0.191)	(0.127)	(0.186)	(0.130)	(0.188)	(0.132)
Veteran	1.687**	0.662	1.730**	0.659	1.704**	0.696
	(0.404)	(0.201)	(0.422)	(0.203)	(0.417)	(0.215)
Republican			2.445***	0.412***	2.439***	0.420***
			(0.373)	(0.0817)	(0.375)	(0.0838)
Intl Issues Interest					0.702**	1.094
					(0.122)	(0.218)
Mil Policy Interest					1.668**	0.690*
					(0.361)	(0.145)
Constant	0.397***	0.871	0.285***	1.036	0.219***	1.316
	(0.140)	(0.310)	(0.104)	(0.375)	(0.0876)	(0.523)
Observations	1,221	1,221	1,221	1,221	1,221	1,221
seEform in parentheses						
*** p<0.01, ** p<0.05, *p<0.1						

E. ROBUSTNESS CHECK

It is possible that the statistically significant findings for my key independent variable occur only due to the specific threshold that was selected for passing the scientific knowledge exam. Therefore, I conducted a robustness check by altering the passing level that determines whether the respondent demonstrates civic scientific literacy. Figure 2 displays the grade distribution for the scientific knowledge test with selected thresholds used for the robustness check.

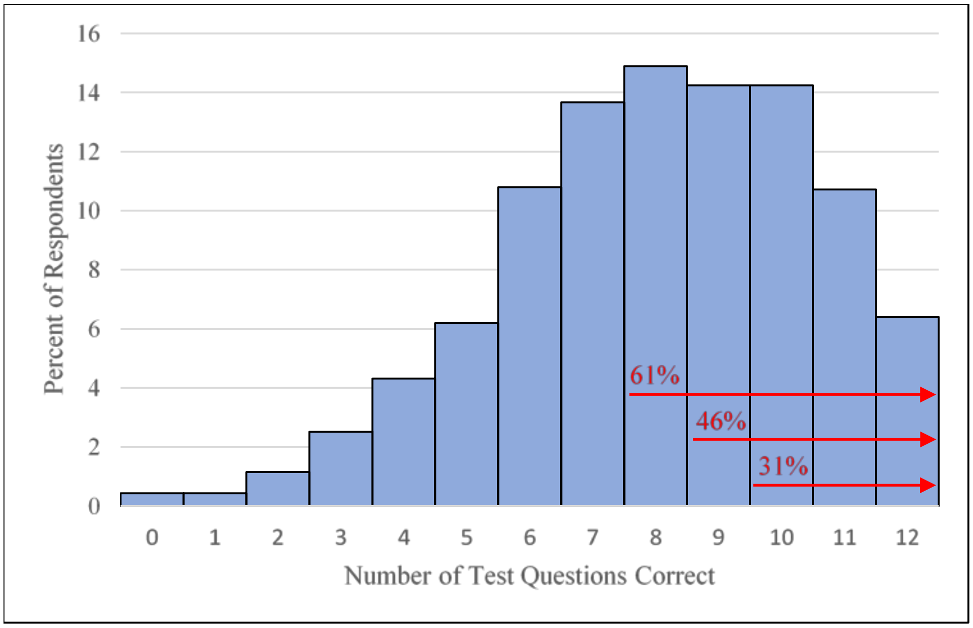

Figure 2. Test Distribution and Passing Thresholds

As previously noted, the passing threshold for the scientific knowledge test was set at 10 correct questions or more out of the 12 total because this level provides a scientific literacy rate of around 31 percent, which is close to the 28 percent level that Miller (2016) found for American adults over the past decade. However, for Miller's test analysis, respondents passed the exam when they scored above 67 percent. Yet, for my exam, comprised of easier closed-ended questions, 10 of 12 correct corresponds to an 84 percent score on the test. Therefore, Table 6 provides a robustness check by running my most comprehensive regression model for lower passing thresholds. Roughly 46 percent of test takers answered nine or more questions correctly with a passing threshold of 75 percent. Approximately 61 percent of test takers answered eight or more questions correctly demonstrating a passing threshold of 67 percent, the same used by Miller. Table 6 shows regression results for two lower thresholds (75 percent and 67 percent) as well as the previously used 84 percent level.

Table 6. Robustness Check Regressions

VARIABLES	Model 1		Model 2		Model 3	
	(1)	(2)	(3)	(4)	(5)	(6)
Reported as relative risk ratios	Too Little	Too Much	Too Little	Too Much	Too Little	Too Much
Sci Literacy 67%	1.045	1.718***				
	(0.169)	(0.322)				
Sci Literacy 75%			0.986	2.111***		
			(0.156)	(0.380)		
Sci Literacy 84%					1.010	1.884***
					(0.168)	(0.340)
Female	1.271	0.502***	1.272	0.507***	1.273	0.510***
	(0.199)	(0.0837)	(0.199)	(0.0849)	(0.199)	(0.0852)
Black	0.820	0.803	0.809	0.857	0.812	0.780
	(0.172)	(0.179)	(0.169)	(0.191)	(0.168)	(0.170)
Other Race	0.619*	0.803	0.614*	0.834	0.613**	0.780
	(0.154)	(0.205)	(0.153)	(0.213)	(0.153)	(0.198)
Age 26–35	1.574	0.943	1.582	0.991	1.596	1.033
	(0.489)	(0.267)	(0.491)	(0.282)	(0.495)	(0.293)
Age 36–45	2.370***	0.778	2.377***	0.817	2.394***	0.870
	(0.764)	(0.244)	(0.765)	(0.258)	(0.772)	(0.274)
Age 46–55	1.810*	1.021	1.812*	1.076	1.828*	1.138
	(0.569)	(0.304)	(0.569)	(0.322)	(0.575)	(0.340)
Age 56–65	2.563***	0.571*	2.564***	0.603	2.582***	0.616
	(0.780)	(0.175)	(0.780)	(0.186)	(0.787)	(0.190)
Age 66 and older	3.273***	0.665	3.250***	0.719	3.278***	0.715
	(1.001)	(0.209)	(0.997)	(0.228)	(1.006)	(0.226)
Inc $25K-$49.9K	1.173	1.359	1.172	1.343	1.170	1.312
	(0.245)	(0.307)	(0.244)	(0.304)	(0.244)	(0.295)
Inc $50K-$74.9K	1.512*	1.231	1.512*	1.184	1.504*	1.184
	(0.347)	(0.314)	(0.347)	(0.304)	(0.345)	(0.302)
Inc $75K-$109.9K	1.250	0.623*	1.260	0.587*	1.251	0.593*
	(0.312)	(0.178)	(0.315)	(0.169)	(0.311)	(0.171)
Inc $110K-149.9K	1.179	0.864	1.180	0.838	1.177	0.840
	(0.354)	(0.281)	(0.354)	(0.274)	(0.353)	(0.274)

VARIABLES	Model 1		Model 2		Model 3	
	(1)	(2)	(3)	(4)	(5)	(6)
Reported as relative risk ratios	**Too Little**	**Too Much**	**Too Little**	**Too Much**	**Too Little**	**Too Much**
Inc above $150K	1.024	0.940	1.026	0.895	1.019	0.880
	(0.331)	(0.321)	(0.330)	(0.308)	(0.328)	(0.304)
High School	1.013	0.998	1.030	0.948	1.024	1.049
	(0.244)	(0.284)	(0.247)	(0.270)	(0.244)	(0.295)
Junior College	1.000	1.477	1.023	1.384	1.014	1.529
	(0.335)	(0.556)	(0.342)	(0.523)	(0.337)	(0.573)
Bachelor's Degree	0.796	1.931**	0.820	1.720	0.815	1.947**
	(0.235)	(0.645)	(0.243)	(0.579)	(0.240)	(0.646)
Graduate Degree	0.717	2.146**	0.737	1.900*	0.727	2.089**
	(0.236)	(0.758)	(0.243)	(0.676)	(0.238)	(0.738)
Married	1.164	0.731*	1.162	0.713*	1.162	0.715*
	(0.188)	(0.135)	(0.187)	(0.133)	(0.188)	(0.132)
Veteran	1.707**	0.720	1.701**	0.697	1.704**	0.696
	(0.417)	(0.222)	(0.416)	(0.217)	(0.417)	(0.215)
Republican	2.428***	0.414***	2.437***	0.416***	2.439***	0.420***
	(0.374)	(0.0824)	(0.375)	(0.0830)	(0.375)	(0.0838)
Intl Issues Interest	0.700**	1.112	0.705**	1.101	0.702**	1.094
	(0.122)	(0.221)	(0.123)	(0.220)	(0.122)	(0.218)
Mil Policy Interest	1.673**	0.707*	1.667**	0.698*	1.668**	0.690*
	(0.362)	(0.149)	(0.361)	(0.147)	(0.361)	(0.145)
Constant	0.217***	1.207	0.220***	1.228	0.219***	1.316
	(0.0875)	(0.485)	(0.0882)	(0.491)	(0.0876)	(0.523)
Observations	1,221	1,221	1,221	1,221	1,221	1,221
seEform in parentheses						
*** p<0.01, ** p<0.05, *p<0.1						

Model 3 of Table 6 is the most comprehensive model using the original threshold of 10 of 12 questions correct, or an 84 percent passing threshold on the scientific knowledge exam. Model 1 and Model 2 demonstrate that the results are robust to changes in the passing level for the exam. That is, the results hold up when the threshold for demonstrating scientific literacy is reduced to lower levels that some might consider more reasonable for a passing exam score. The direction and general magnitude of the results are similar for both Model 1 and Model 2 relative to Model 3. When the passing level for the scientific knowledge test is reduced to 67 percent, I find that compared to those fail the exam, those who pass the exam are 1.72 times more likely to think we spend too much on the military. When the threshold increases to 75 percent, compared to those who fail the test, those who pass the test are 2.11 times more likely to hold the opinion that the country spends too much on defense. My initial results for the 84 percent passing threshold falls in between these two figures.

F. KEY FINDINGS

Even with a varying number of controls, all my multinomial logistic regression models show a statistically significant relationship between scientific knowledge or civic scientific literacy and opinions on military spending. Survey participants that I classified as passing the GSS scientific knowledge test were far more likely to think that the country spends too much money on defense relative to about the right amount. These findings were also robust to changes in the passing level for the exam.

Specific controls of interest provided both expected and unexpected results. Veterans and Republicans were both much more likely to believe we spend too little on the military. The oldest age group (those 66 and older) were also far more likely to feel that too little is spent on defense. Compared to those with less than a high school diploma, respondents with a bachelor's or graduate degree were much more likely to think the nation spends too much on the military. Female respondents provided the most surprising finding. Compared to men, this group was less likely to think we spend too much on defense, showing nearly the same magnitude and direction as Republicans.

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V. CONCLUSION

I began this research to investigate the association between scientific knowledge and military spending preferences. I wanted to understand the dynamic between civic scientific literacy among voting age Americans and their opinions on defense spending levels. With approximately 28 percent of the adult population qualifying as being scientifically literate, I decided to assess whether this informed minority maintained any particular beliefs about government spending on the military.

Using data from the 2016 GSS, I created a scientific knowledge test and determined a passing threshold that would signify scientific literacy among respondents. For my key independent variable of interest, the results were both economically and statistically significant. Using multinomial logistic regression models, I found those exhibiting scientific literacy were 1.88 times more likely to believe our country spends too much on the military relative to individuals with no scientific literacy. Regardless of the sequential addition of various categories of controls, the multinomial logistic regression models showed the same directional viewpoint with a similar magnitude. Relative to respondents who failed the scientific knowledge exam, those who passed were substantially more likely to hold the opinion that we spend too much on defense, even when accounting for veteran status, political party affiliation, and an array of demographic factors.

The 12-item scientific knowledge test had a passing threshold of 83 percent, or 10 correct questions. This threshold was selected because just 31 percent of respondents scored at this level or higher, closely resembling the 28 percent civic scientific literacy level found in the United States by prior research (Miller, 2016). Such a threshold was higher than what may be considered normal for passing a test. However, another key reason for the 10-question level was the structure of the test. The GSS exam was comprised of only closed-ended questions which are easier than open-ended inquiries in prior literature. The question format enabled respondents to guess the correct answer. In most cases individuals had a 50 percent chance of being correct even when not actually knowing the answer or understanding the subject matter. Therefore, the threshold was chosen to not only reflect findings from prior studies, but also to account for the degree of difficulty of the test itself.

To rule out the possibly that this strict threshold was the primary reason for my statistically significant results, I conducted a robustness check by lowering the passing level to 75 percent and 67 percent. My results were robust to these changes, showing that those who pass the exam were still much more likely to believe the country spends too much on the military.

A limitation of my study pertains to the inability to determine why respondents held their personal opinion on military spending. I cannot comment on the reason why those with more scientific knowledge are prone to favor less defense spending. It is important for analysts and policymakers to investigate the reasons for such opinions. If the 2016 GSS included a follow-up question asking why the respondent felt we spend too much or too little, categories of responses could be pooled and included in an analysis. Although polling data has asked more detailed and layered questions, the presence of science knowledge questions makes this study unique.

Due to the limited scope of this research, there is significant room for further study. Other studies related to my results could involve implications to science education reform and how best to fund efforts to improve scientific literacy. Further study could investigate the implications of DoD public relations campaigns. If there is a disconnect between military spending trends and the perception of this spending by the public, then public relations may seek different methods of outreach to explain costs to voters. The same would hold true for other government agencies, such as NASA and the Department of Energy, who also have significant science and technology related budgets.

In conclusion, this research provides valuable insight into the role of scientific knowledge on political views related to defense spending. The findings may be useful as the defense budget potentially shrinks with federal budget deficits continuing to rise. Given the positive views that the U.S. population has about the military, these types of studies are beneficial for us to use a benchmark to understand what preferences voting-age adults hold regarding military spending levels.

My research may have considerable implications for the education, scientific, and government communities. The alarming trends regarding scientific understanding are in need of correction, as technologies are only becoming more complex and more prevalent throughout society. Future research can highlight the importance of scientific knowledge among the populace and begin to remedy shortcomings. Associations between levels of scientific knowledge, policy knowledge, or current events and defense spending can inform policymakers about communication strategies with the public. DoD funding decisions could be communicated differently to different demographic groups to garner more support. Any tactics or changes to messaging can influence voting habits and potentially help shape policy across many disciplines with both short and long-term consequences.

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